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Norms for an Abbreviated Raven's Coloured Progressive Matrices in an Older Sample

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Percentile age norms for ages 55 to 85 using overlapping intervals at specified age midpoints are presented for the sum scores of sections A and B of Raven's Coloured Progressive Matrices (RCPM). The representative age and gender stratified sample ($N = 2,815$) used is derived from the Longitudinal Aging Study Amsterdam (the Netherlands). As RCPM scores appear to be strongly associated with education, percentile norms for three educational levels are presented: low (0–9 years), middle (10–15 years) and high (16 years and more). © 1997 John Wiley & Sons, Inc. J Clin Psychol **53**: 687–697, 1997.

Intelligence measures have been used in gerontological research to study both "normal" and pathological cognitive decline (e.g., Carver, 1989; Diesfeldt & Vink, 1989; Lezak, 1983; Villardita, 1985). Furthermore, intelligence tests have proven to be good predictors of performance in daily life in the elderly (Cockburn et al., 1990; Rabbitt, 1984, 1988). The distinction between "crystallized intelligence" (reflective of experience) and "fluid intelligence" (the ability to deal with essentially new problems) (Horn, 1985) is of special interest in gerontology. The former has been shown to remain fairly constant whereas the latter, presumably related to one's neurophysiological status, is particularly vulnerable to decrement associated with aging.

Raven's Coloured Progressive Matrices (RCPM; Raven, 1984) is a frequently used test of fluid intelligence in gerontological research (e.g., Cockburn & Smith, 1991; Diesfeldt & Vink,

This study is based on data which were collected in the context of the Longitudinal Aging Study Amsterdam (LASA), conducted at the Department of Psychiatry and the Department of Sociology and Social Gerontology of the Vrije Universiteit, Amsterdam, The Netherlands. The study is funded by the Ministry of Health, Welfare and Sports.
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1989; Panek & Stoner, 1980; Villardita, 1985). It was originally constructed as a test of eductive reasoning, which can be described as the ability to make "meaning out of confusion" or the ability to go "beyond the given to perceive that which is not immediately obvious" (Raven, Raven & Court, 1991, p. G1). The RCPM was developed for use in both experimental and survey situations (homes, schools, and workplaces) to assess general intellectual development (Carver, 1989; Schmitz–Scherzer & Thomae, 1983). Its clinical use is based on the demands which various items make on the two hemispheres (Lezak, 1983). Apart from lateralization, assessment of focal brain damage has been the purpose of administration of the RCPM (Villardita, 1985).

The RCPM contains three sections (A, Ab, and B) of 12 items each. In each item subjects are presented with an incomplete design and six alternatives among which one must be chosen that best completes the design. Every correctly solved item results in a score 1. Sumscores may be used for every section or for the total RCPM. The items increase in difficulty, and so do the three sections. Knowledge acquired by answering previous items is necessary in order to answer a subsequent item, which implies that the respondent is expected to learn from items. The RCPM is an attractive instrument to measure fluid intelligence in an older population because of its good and well documented psychometric properties and because of its "culture-fairness": little verbal instruction is needed and research has demonstrated that the test is equally reliable for ethnic groups (e.g., Carlson & Jensen, 1981). This is, presumably, also the case for different generations (Carver, 1989). The attraction of the RCPM is also apparent from its design. The matrices themselves are colored large-print drawings which are also visible for older subjects with modestly impaired eyesight. The fact that the test starts with easy items is encouraging for the respondent as (s)he gets the impression that at least a number of items have been correctly answered. Finally, administration and scoring of the RCPM are relatively easy and cost effective.

Despite the frequent use of the RCPM in older populations there has been a lack of normative data. Most data that do exist were collected over 30 years ago or refer to small nonrepresentative samples (Foulds & Raven, 1948; Orme, 1957; Raven, 1965; Raven et al., 1978). Recently, Measso et al. (1993) published norms for ages 20 to 79. The number of respondents on which their norms for the age groups 55 and older are based, however, is small. The same can be said of the data published on a Japanese older sample (Sugishita & Yamazaki, 1993). All reported data show lower RCPM scores for the older age groups. These age differences underline the value of age norms. What is more important, however, when using age norms, is the fact that test performance of a particular age group or cohort appears to increase with one standard deviation over 30 years (Diesfeldt & Vink, 1989; Flynn, 1987; Raven & Court, 1989). This process is probably because of improved education and health care. This "cohort effect" underlines the necessity of up-to-date age norms. Clinical use of the RCPM is only meaningful when a subject's results can be compared to a standard (representing normality) which is appropriate for that individual. This article aims to provide norms for an abbreviated version of the RCPM, consisting of sections A and B, by presenting the results of a large survey amongst a Dutch representative sample of adults aged 55 to 85 years.

Previous studies have occasionally reported gender differences (Measso et al., 1993; Schmitz–Scherzer & Thomae, 1983) and regularly educational effects (Diesfeldt & Vink, 1989; Measso et al., 1993). Therefore, apart from the age variable, the effects of gender and education will be studied to see if separate norms for the sexes and for different educational classes are necessary.

METHOD

Overall Sample Description

The present study is part of the Longitudinal Aging Study Amsterdam (LASA), a 10-year interdisciplinary, longitudinal study on predictors and consequences of changes in autonomy

and well-being in the aging population (Deeg et al., 1993). A random sample stratified by year of birth, gender and expected mortality at midterm (i.e., after five years) in six age groups (55–59, 60–64, 65–69, 70–74, 75–79, 80–84 years) was drawn from the population registries of 11 municipalities. These municipalities were situated in three different areas in the Netherlands. Each area consists of one middle to large size city and two or more rural municipalities which border on the city. The primary intention was to obtain a representative sample of older Dutch males and females in various age categories and to reflect the national distribution of urbanization and population density. LASA is linked to the NESTOR-program: Living arrangements and social networks of older adults (NESTOR-LSN). The study design and the sampling procedures of NESTOR-LSN and LASA are described in detail elsewhere (Broese van Groenou et al., 1995; Smit & de Vries, 1994, respectively). In summary, NESTOR interviewed 3,805 respondents (response: 62.3%) from January until August 1992. Of these respondents 3,545 respondents were able to participate in LASA (126 persons were deceased and 134 persons were not able because of cognitive and/or physical conditions (ineligible)). LASA approached these 3,545 respondents from September 1992 until October 1993. Of these 3,545 persons a total of 3,107 (87.6%) participated in the LASA interview, which included the RCPM. The major source of nonresponse was a lack of motivation to participate ($n = 394$, 11.1%). A total of 44 persons could not be contacted (1.2%). Differences in participation by gender were not found. Significant differences in reasons for nonparticipation were found for age. Sample members from the oldest cohorts more often scored "ineligible" as a reason for not participating ($p < .001$). Furthermore, older respondents more often refused to participate in the study ($p < .001$) than younger ones. Finally, no interactions between age and gender for participation in the study were found.

The Sample for Age Specific RCPM Norms

Preliminary psychometric data on the RCPM have been described elsewhere (van den Heuvel & Smits, 1994). Of the 3,107 LASA respondents a total of 198 persons with severe health problems were approached with a shortened version of the interview in which the RCPM was not included. Of the 2,916 remaining respondents 2,815 respondents participated in the present study. One hundred one respondents (3%) did not complete the test because of bad eyesight (21) or lack of motivation (80). Demographic and educational characteristics for the final normative sample are presented in Table 1.

As can be seen from Table 1, all age groups are fairly equally represented. The number of male and female respondents is also balanced. A relatively large proportion of the sample only had low education. This is to be expected as the present older cohorts in the Netherlands have had relatively little education.

Procedure

The interviews were administered by lay interviewers in the respondents' home environment. Laptop computers were used for data entry. Interviewers were recruited via local newspaper advertisement and bulletin boards at local universities. Selection criteria were experience with survey interviews, social skills and basic computer experience. A total of 43 interviewers (41 women and 2 men) were selected.

The training of the interviewers lasted five sessions of 6 hours each. Video-examples illustrating basic interviewing rules and role playing were used to practise interviewer skills. The training of the RCPM was done by a licensed psychologist (first author) following the guidelines in the manual (Raven, 1984). Each interviewer conducted a test interview which was audio taped and discussed. During the fieldwork interviews were audiotaped, individual

Table 1. *Demographic Data of the Normative Sample*

	N	%
Age		
55–59	460	16.3
60–64	494	17.5
65–69	467	16.6
70–74	431	15.3
75–79	495	17.6
80–85	468	16.6
Sex		
Men	1,372	48.7
Women	1,443	51.3
Education		
Low (0–9 years)	1,757	62.4
Middle (10–15 years)	727	25.8
High (16 years or more)	331	11.8

interviewers were monitored and additional group training sessions were held in order to perform quality control on interviewer behavior.

Measures

The RCPM was included in an interview on cognitive, emotional, physical and social functioning. In order to limit respondent's burden (the interview lasted approximately 2 hours) section Ab was left out of the interview. A pilot study, using a representative sample of adults aged 55 and over ($n = 116$), mean age = 71.1 years ($SD = 9.5$), Deeg & Smit, 1993) showed that the sum score of the complete RCPM correlated strongly ($r = .96$) with the sumscores of section A and B. These findings are in line with earlier findings, which had also shown that section Ab contributed little to the differentiation of intellectual capacity at the ages 60–69 (Levinson, 1959). The exclusion of section Ab does not affect the composition of the RCPM, as all item categories distinguished by Raven (1984) are amply represented. Similarly, sufficient items are left representing the categories Static Items (9 out of 12), Concrete Items (7 out of 15) and Abstract Dynamic Items (8 out of 9) (Diesfeldt & Vink, 1989). Furthermore, estimated total scores for the complete RCPM may be calculated from scores on separate sections using tables presented in the manual.

In order to measure education, the respondent was asked for the highest educational course (s)he had completed. Nine answering categories were distinguished, reflecting various types of education, ranging from primary school to university. These were recoded to three answering categories, low, middle, and high education. These categories roughly correspond to a categorization according to number of years of education. Low education corresponds to 0–9 years, middle education to 10–15 years, and high education to 16 years or more.

RESULTS

In Table 2 means, standard deviations, and ranges of section A, B, and the sumscores are presented for 5-year age cohorts and three educational levels. The two sections differ substantially in terms of difficulty. Section A is relatively easy, as mean scores range from 9 to 11.2 correct out of 12. Section B is more difficult with mean scores ranging from 5.7 to 10.5. Standard deviations of section A are also smaller than those of section B.

Table 2. *Means, Standard Deviations, and Ranges for the Coloured Progressive Matrices of Respondents with Lower, Middle, and High Education*

	Low Education (0–9 Years) *n* = 1757				Middle Education (10–15 Years) *n* = 727				High Education (16 Years or More) *n* = 331			
Age	*n*	A	B	Total	*n*	A	B	Total	*n*	A	B	Total
55–59	242				137				66			
M		10.2	8.1	18.3		10.9	9.7	20.6		11.1	10.5	21.6
SD		1.7	2.6	3.8		1.2	2.3	3.1		1.3	1.6	2.3
R		3–12	1–12	5–24		7–12	2–12	9–24		4–12	6–12	13–24
60–64	262				161				67			
M		10.2	8.1	18.3		10.7	9.3	20.0		11.2	10.0	21.3
SD		1.7	2.5	3.7		1.5	2.5	3.4		.8	1.9	2.3
R		0–12	2–12	2–24		3–12	1–12	6–24		9–12	5–12	16–24
65–69	300				126				50			
M		10.0	7.6	17.6		10.8	9.4	20.2		11.1	9.9	21.0
SD		1.8	2.8	4.1		1.2	2.3	2.9		1.0	2.1	2.7
R		1–12	0–12	4–24		6–12	3–12	11–24		8–12	3–12	11–24
70–74	274				118				37			
M		9.7	7.0	16.8		10.2	8.1	18.3		11.2	9.4	20.5
SD		1.9	2.5	3.8		1.6	2.5	3.4		.9	2.3	2.6
R		0–12	1–12	2–24		4–12	1–12	7–24		9–12	3–12	14–24
75–79	346				105				48			
M		9.4	6.4	15.7		10.2	7.6	17.8		10.8	8.9	19.6
SD		1.8	2.4	3.6		1.6	2.8	3.8		1.4	2.4	2.9
R		2–12	0–12	6–24		5–12	1–12	8–24		5–12	2–12	13–24
80–85	333				80				63			
M		8.8	5.5	14.3		9.5	6.6	16.1		9.9	7.6	17.4
SD		2.0	2.4	3.8		1.9	2.4	3.6		2.2	2.7	4.2
R		0–12	0–12	2–24		4–12	2–12	7–24		2–12	2–12	6–24

Table 2 highlights education and age effects. The older age groups perform less well than their younger colleagues on both RCPM sections and hence on the sumscores. Scores appear to be lower from ages 65–70 years upwards. Performance on both sections and on the sumscores increases with level of education. Furthermore, standard deviations are larger for the older age groups and for respondents with relatively less education. An analysis of variance model (ANOVA) was used to assess the relationship between RCPM score and gender, age (in 5-year cohort), education (low, middle, high) and interaction terms. Both age ($F(5,2809) = 1201.1$, $p < .001$) and education ($F(2,2812) = 2062.0$, $p < .001$) effects were significant. Gender ($F(1,2813) = 2.2$; *ns*) and interaction terms were not significant.

As age and education apparently affect RCPM performance, age norms for the different educational categories are presented.

Percentile Tables

As a minimum of 50 subjects per age group interval is necessary to provide stable information of population means and norm values of intelligence tests (D'Elia et al., 1989) this minimum is aimed at in the norm tables.

Pauker (1988) suggested overlapping intervals at specified age midpoints in which norm subjects may appear in one or more adjacent cells. Overlapping intervals provide more direct

comparisons for evaluating test results. They offer a reference of persons who surround a specific age point.

Percentile ranges for midpoint ages at 1-year intervals for respondents with a low and middle education are presented in Table 3 and Table 4. The range of ages around each midpoint for respondents with a low education was 1 year (e.g., for midpoint 56 the range was 55–57), for respondents with a middle education 2 years. Percentile ranges for the highly educated elderly are presented for 3 years with a 5-year range around each midpoint (Table 5). These differences in age ranges for the three educational levels result from differences in the numbers of respondents available in each group (Table 1), because of the representative nature of the sample. For brevity reasons, all tables present data for the total score (section A and B) on the RCPM.

The percentile ranks clearly show how the percentage of respondents able to solve a particular number of items decreases with the age and increases with the education of the respondent. As an example (Table 3), of the group aged 55–57 years with low education 26% can solve more than 20 out of 24 items, whereas this is only 1% for those aged 83–85. Similarly, of the respondents with high education (Table 5) aged 55–66 years, 61% can solve more than 20 out of 24 items, whereas this is 23% in the oldest group (73–85 years).

DISCUSSION

The present study aims to provide RCPM norms for adults aged 55 to 85 years. These are provided for separate age groups and for three educational levels (low, middle, and high). The sample used for the RCPM norms consisted of 2,815 respondents. The size of the sample provides a unique basis for our purposes. The LASA sample used was age and gender stratified and aimed to be representative of the Dutch older population.

The choice of a representative sample in a normative study may be disputed on the grounds that the resulting norms may reflect both intelligence and cognitive disorder, as a certain proportion of the older adults may be expected to suffer from dementia or related diseases. This disadvantage may be overcome by excluding these pathological respondents (e.g., on the grounds of their score on the Mini Mental Status Examination; Folstein et al., 1985; Folstein et al., 1975). However, as the MMSE score is associated with education (Launer et al., 1994) this would result in the exclusion of relatively many nonpathological cases in the groups with low education and the inclusion of relatively many pathological cases in the groups with high education.

Overlapping intervals at specified age midpoints allow for direct comparisons for evaluating test results. This sample contained relatively more respondents with low education than respondents with high education (as does the older population), which implies very detailed and thus refined age group norms for this category.

The norms provided refer to sections A and B, as section Ab was not included in the study. They will be useful nevertheless, as any researcher or clinician using the RCPM will have data available on the sections selected. The norms provided may be extrapolated to the complete version of the RCPM using tables of estimated scores published in the manual.

The selection of section A and B makes comparison of the present results with earlier findings difficult as many studies only produce psychometric data on the total RCPM. Furthermore, the age categories used do not always correspond and educational levels are often not distinguished. Taking these limitations into account, the following preliminary conclusions may be drawn. Our results are in line with data on another Dutch sample (Diesfeldt & Vink, 1989). The present mean scores appear to be significantly higher than those presented as the early English normative sample (Orme, 1957), providing further evidence of intellectual improvement over cohorts. The mean scores on section A seem to be similar to recent Japanese data (Sugishita & Yamazaki, 1993). The scores on section B, however, appear to be somewhat

Table 3. *Percentile Ranks for RCPM Total Score by Midpoint Age Groupings, Low Education*

	Midpoint age groupings													
	56	57	58	59	60	61	62	63	64	65	66	67	68	69
	55–57	56–58	57–59	58–60	59–61	60–62	61–63	62–64	63–65	64–66	65–67	66–68	67–69	68–70
n =	105	103	104	113	106	92	99	116	125	122	117	121	115	113
Score														
≤10	4	2	4	4	3	2	3	3	4	3	3	4	6	5
11	6	3	6	6	4	5	6	7	7	5	4	7	10	7
12	7	4	7	7	4	8	8	8	10	8	11	13	15	12
13	10	8	9	8	6	13	14	10	11	12	18	18	19	18
14	14	13	18	15	10	17	17	14	16	20	28	25	24	23
15	20	19	26	20	17	25	22	22	25	25	32	31	30	29
16	29	25	36	29	26	36	35	34	32	32	39	36	34	42
17	36	33	43	36	33	42	43	42	39	37	46	46	49	57
18	42	44	53	43	44	52	54	52	47	45	56	56	58	67
19	55	53	60	55	52	57	60	60	55	53	65	66	67	74
20	67	65	70	65	59	65	71	71	64	66	77	74	77	82
21	74	73	77	76	75	77	79	81	76	73	83	81	83	89
22	86	85	90	88	85	83	85	89	86	85	92	88	86	94
23	94	94	98	98	96	96	96	94	92	92	97	98	98	98
24	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
	69–71	70–72	71–73	72–74	73–75	74–76	75–77	76–78	77–79	78–80	79–81	80–82	81–83	82–84	83–85
n =	113	118	104	100	121	132	134	134	148	151	132	124	136	128	65
Score															
≤10	7	10	8	3	4	6	8	10	10	13	13	15	21	20	15
11	8	13	11	4	6	12	15	15	17	19	19	25	30	24	19
12	10	15	14	10	13	19	22	19	20	30	33	32	37	33	26
13	19	23	17	12	16	26	28	24	29	36	40	42	46	48	46
14	25	31	27	22	23	30	31	32	39	44	52	54	55	58	54
15	31	40	38	32	36	43	44	43	48	54	61	61	65	69	66
16	46	51	46	43	52	57	55	53	59	64	67	67	74	81	75
17	60	64	57	51	58	65	67	68	69	72	74	69	77	85	82
18	69	73	67	63	69	78	81	80	79	83	85	78	85	93	92
19	76	80	75	77	80	84	89	89	86	87	90	86	90	96	94
20	81	86	86	84	87	89	93	92	91	93	95	90	93	98	95
21	85	88	89	92	94	92	95	96	96	97	98	94	95	98	99
22	92	93	93	95	98	96	97	98	99	100	99	97	98	99	99
23	97	98	98	98	99	99	99	98	99	100	99	99	100	99	99
24	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 4. *Percentile Ranks for RCPM Total Scores by Midpoint Age Groupings, Middle Education*

	Midpoint age groupings													
	57	58	59	60	61	62	63	64	65	66	67	68	69	70
	55–59	56–60	57–61	58–62	59–63	60–64	61–65	62–66	63–67	64–68	65–69	66–70	67–71	68–72
n =	109	121	117	121	132	123	122	112	98	98	104	104	97	98
Score														
≤10	1	2	1	2	3	3	3	2	0	0	0	1	1	2
11	3	2	3	3	4	4	3	3	0	1	1	2	2	2
12	4	2	3	3	4	4	3	3	1	3	4	6	5	4
13	4	3	3	4	6	6	5	4	1	3	4	7	6	5
14	5	4	4	6	8	7	7	5	3	5	7	10	9	7
15	5	4	4	6	8	8	8	6	6	8	10	13	13	13
16	8	8	9	10	12	13	14	10	8	11	13	16	19	20
17	12	13	15	16	21	21	21	17	12	15	15	21	27	32
18	18	19	21	22	30	29	30	24	15	21	21	27	33	40
19	24	24	27	30	36	39	41	36	28	30	32	37	43	49
20	34	35	39	42	46	47	47	41	40	44	51	58	62	67
21	49	50	52	51	58	60	61	56	56	59	64	72	75	80
22	72	70	73	68	74	76	77	78	71	75	78	83	88	89
23	89	87	87	84	89	89	90	94	90	89	90	89	94	95
24	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	71	72	73	74	75	76	77	78	79	80	81	82	83	
	69–74	70–75	71–76	72–77	73–78	74–79	75–80	76–81	77–82	78–83	79–84	80–85	81–86	
n =	96	94	101	96	85	91	82	72	68	57	63	62	54	
Score														
≤10	3	2	3	4	4	4	4	1	6	7	10	10	6	
11	4	3	4	5	5	7	10	10	13	16	14	13	9	
12	8	7	8	9	6	8	11	11	16	21	19	18	13	
13	9	9	11	14	11	13	15	14	19	23	22	21	17	
14	10	12	13	18	15	17	18	15	24	30	35	37	33	
15	18	20	20	24	22	27	31	28	34	40	44	47	44	
16	25	29	29	31	31	36	42	38	44	51	54	60	58	
17	39	42	42	43	44	47	48	49	54	63	68	69	70	
18	47	54	56	54	55	55	55	60	66	75	79	79	80	
19	54	64	65	65	65	59	59	63	68	79	84	86	87	
20	69	75	75	73	73	69	72	75	78	88	86	90	93	
21	83	84	83	81	80	78	81	83	85	95	92	94	94	
22	91	90	89	87	86	86	89	93	93	98	97	97	98	
23	95	95	95	96	97	99	99	100	99	98	97	97	98	
24	100	100	100	100	100	100	100	100	100	100	100	100	100	

Table 5. *Percentile Ranks for RCPM Total Scores By Midpoint Age Groupings, High Education*

	Midpoint age groupings						
	60.5	64	67	70	73	76	80
	55–66	59–69	62–72	65–75	68–78	71–81	73–85
n =	143	117	89	80	86	92	111
Score							
≤10	0	0	0	0	0	3	5
11	0	1	1	1	1	3	5
12	0	1	1	1	1	5	7
13	1	1	1	3	4	9	11
14	1	2	3	6	6	13	16
15	1	3	5	9	8	15	22
16	2	4	7	13	13	20	27
17	10	10	10	15	16	28	38
18	15	17	17	24	23	34	43
19	19	22	24	36	37	46	53
20	26	29	32	45	48	55	64
21	39	40	44	59	62	72	77
22	59	63	67	73	76	83	89
23	85	89	94	94	93	95	96
24	100	100	100	100	100	100	100

higher for the Dutch sample than for the Japanese. As the age and education categories of the Japanese and present study do not correspond, no conclusions may be drawn from this difference.

Administration of the RCPM in a representative sample of older adults by lay interviewers appeared to offer no special problems. A small proportion of respondents did not participate due to lack of motivation or bad eyesight, which underlines the value of the RCPM in an older population. The fact that in a representative sample a number of respondents could not participate because of vision impairment should once more alert both clinicians and researchers in their choice of intelligence tests with older patients. As the RCPM is one of the measures acceptable for subjects with impaired eyesight, the use of some other intelligence tests may result in larger numbers of subjects not able to perform on the task due to eyesight limitations.

Although the RCPM was designed to be used in older adults (among others), questions may be raised on the discriminative power of section A in the younger old and in the highly educated elderly, as the present data suggest a ceiling effect in these categories.

The clinical use of the RCPM will certainly benefit from the present data, although further research is needed to provide norms for those respondents showing neurological or other disorders.

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